Wi-Fi Roaming Guidelines

About the Wireless Broadband Alliance

Founded in 2003, the aim of the Wireless Broadband Alliance (WBA) is to secure an outstanding user experience through the global deployment of next generation Wi-Fi. The WBA and its industry leading members are dedicated to delivering this quality experience through technology innovation, interoperability and robust security.

Today, membership includes major fixed operators such as BT, NTT Communications, Comcast and Time Warner Cable; seven of the top 10 mobile operator groups (by revenue) and leading technology companies such as Cisco, Google and Intel. WBA member operators collectively serve more than 1 billion subscribers and operate more than 1 million hotspots globally. They also work with international operators to drive innovation, deliver seamless connectivity and optimize network investments.

The WBA Board includes AT&T, BT, Boingo, China Mobile, Cisco, Intel, iPass, KT, NTT DOCOMO and Orange France.

More information about WBA: contactus@wballiance.com

www.wballiance.com
www.twitter.com/wballiance

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Executive Summary

This document examines the commercial and technical aspects of how to make Wi-Fi roaming—the automatic provisioning of connectivity to end-users across different service providers' Wi-Fi networks—available to personal devices. The Wireless Broadband Alliance (WBA) defines roaming set-up best practices for service providers and outlines the reasons for providing roaming services as well as suitable strategies to adopt. Standards are provided for the type of information needed from the Wi-Fi network, together with guidelines on how to exchange relevant information between involved parties.

1. INTRODUCTION

1.1 Scope and objectives

The scope of this WBA Wi-Fi roaming guidelines is to present an overview of the WBA framework for Wi-Fi roaming and to provide a guide on how to get started with Wi-Fi roaming services.

This document is aimed at operators, aggregators and hub providers who are planning to start a Wi-Fi roaming service, or who already have a roaming service but want to get a better understanding of the WBA framework. It can also be used as a training tool to provide a better understanding of how Wi-Fi roaming business operates.

The document refers to public Wi-Fi services, and specifically the development of hotspots in public locations.

The WBA Roaming Guidelines is organized into 5 chapters:

The introduction sets out the scope of the document together with a definition of Wi-Fi roaming, the main reasons why Wi-Fi roaming is a relevant topic today and an overview of the different players within the Wi-Fi ecosystem.

Chapter two outlines the importance of having a precise strategy in order to develop a Wi-Fi roaming business, and gives guidelines and examples of best practice.

Chapter three sets out the different stages of development that must be followed by operators wanting to implement a Wi-Fi roaming service.

Chapter four gives guidelines and examples of best practice to operators regarding the delivery and maintenance of Wi-Fi roaming services.

And chapter five provides a short explanation of the WBA and its role within the Wi-Fi roaming industry.

1.2 What is Wi-Fi roaming?

A roaming service is the Wi-Fi service provided by the visited network provider (VNP) to the customer using the VNP's Wi-Fi network(s) and the home service provider's (HSP's) customer relationship.

National roaming takes place when the VNP and the HSP are located in the same country, while international roaming refers to the customer using a VNP in another country. This distinction is particularly relevant to Wi-Fi because it is a non-regulated spectrum technology that operators can deploy in their own and other countries.

The roaming process between two operators can be divided into two major activities: firstly, the technical interconnection between networks either directly or using an intermediary hub, where all real-time activities such as authentication and accounting are performed; and secondly, the commercial aspects of roaming, such as billing, charging and tariffs.

1.3 Reasons for Wi-Fi roaming

4 main factors are putting Wi-Fi roaming high on the agenda of operators.

The sharp rise in the use of devices such as smartphones, tablets, and digital cameras with connectivity, is putting pressure on operators' networks. The subsequent increase in wireless data traffic is forcing operators to look for alternative network technologies in order to deliver a consistent experience and sufficient bandwidth to their customers.

Wi-Fi technology is also attracting interest because of high retail tariffs for international wireless data roaming, which causes customers to reduce consumption or switch off data services altogether when in another country.

The increase in the number of handheld devices with Wi-Fi capability is also driving momentum. Not only are there more dual-mode handsets (mobile-to-Wi-Fi), but there is also a range of new devices such as tablets, digital cameras and gaming consoles, all of which require Wi-Fi connectivity to be widely available.

In addition, there have been innovations around the Wi-Fi user experience, such as the Wi-Fi Alliance's CERTIFIED Passpoint™ program and the Wireless Broadband Alliance's Next Generation Hotspot program. Such developments bring functions to Wi-Fi that end users associate with cellular services, such as automatic network discovery and selection, radio link security and automatic authentication using Extensible Authentication Protocols (EAP), including EAP SIM authentication (see glossary p.30)..

1.4   Wi-Fi ecosystem

Wi-Fi is an unregulated technology, so the barriers to entering the market are quite low. Different types of players, in addition to telecoms operators, can decide to develop a Wi-Fi business by deploying hotspots.

It is important to distinguish between a hotspot service provider and a hotspot owner. A hotspot service provider manages a hotspot, and does not need to be the owner of the venue where the Wi-Fi antennas are located. A hotspot owner is responsible for the venue where the antennas are installed, such as a hotel or café, but is not necessarily the provider of the service. While the hotspot owner can also be the hotspot service provider, the two are usually different.

Hotspot service providers can be divided into two main groups: operators and non-operators. For example, an airport authority can be a hotspot service provider, while the owner of a café or hotel can install a Wi-Fi hotspot and set up a commercial agreement with an external service provider.

This document focuses on hotspot service providers that are operators, and within this category we can identify 4 further subdivisions:

Pure Wi-Fi operators that only carry out business related to Wi-Fi services

Licensed mobile network operators or virtual network operators (MVNOs) that also provide Wi-Fi services

Integrated operators that provide a range of services such as fixed, mobile, internet, broadband and Wi-Fi

Fixed and cable operators that often also provide broadband and TV services.

Within the Wi-Fi ecosystem we can identify the following players:

- Operators
- End customers
- Wireless Roaming Intermediary eXchange (WRIX)/Hub providers
- Aggregators/Resellers
- Infrastructure vendors
- Device vendors
- Connection manager vendors
- Clearing houses

Each has a particular role in the development of the Wi-Fi ecosystem and in particular on roaming business, as shown in figures 1 and 2:
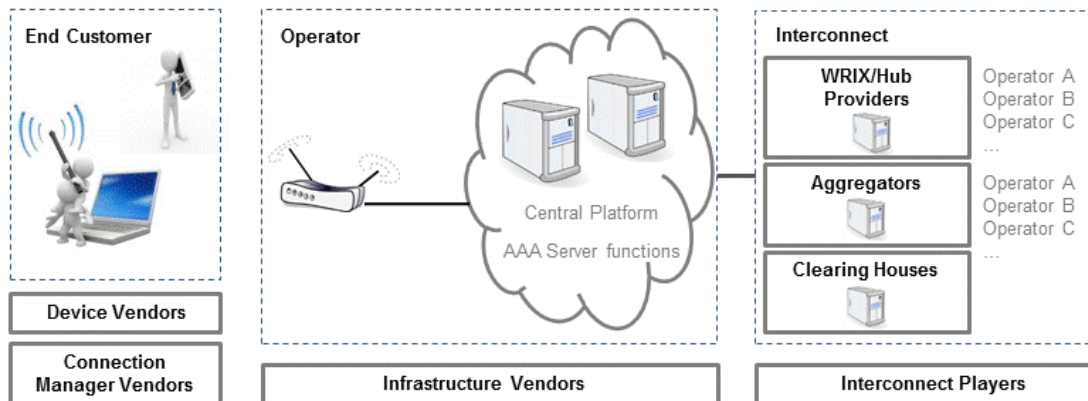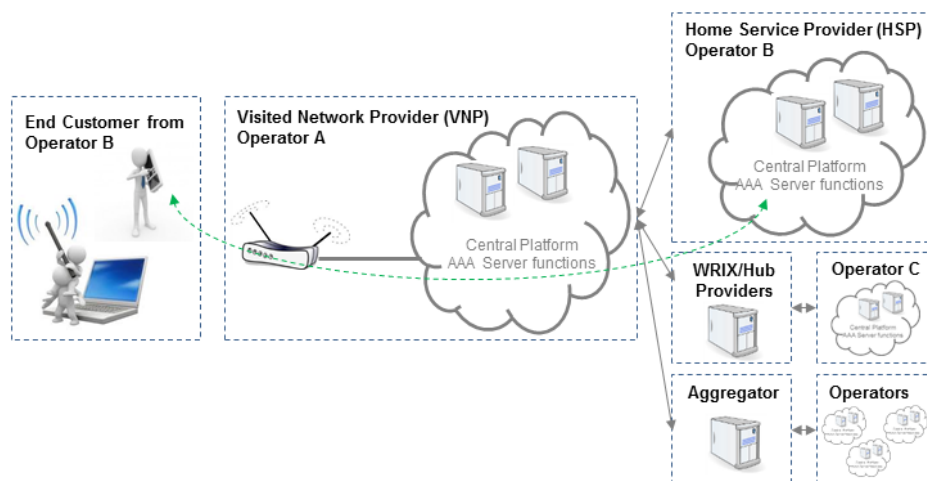
Figure 1: Wi-Fi ecosystem

Figure 2: Wi-Fi roaming service ecosystem

2. STRATEGY FOR Wi-Fi ROAMING

2.1 Wi-Fi roaming services

The roaming-related work accomplished by the WBA and the collective strengths of its members have been instrumental in the growth of global Wi-Fi roaming. The WBA facilitates access to a quality global Wi-Fi footprint, a huge subscriber base, unique expertise and track record, and award-winning technical enablers. The WBA also provides opportunities to engage global partners and influence the industry. It offers a significant value proposition to all wireless broadband operators and ecosystem partners interested in enabling a seamless Wi-Fi experience, delivering global Wi-Fi roaming and integrating Wi-Fi across mobile technologies for the benefit of end-users.

Operators with Wi-Fi networks

Operators who own public Wi-Fi networks (whether as a stand-alone business or as a key complement to their wireless and/or broadband networks) can benefit from many advantages through membership of the WBA. It is an ideal forum to enhance their global coverage and inbound/outbound roaming opportunities for their users. As well as extending technical enablers and providing templates for operators, the WBA has developed common user experience guidelines to make it easier for end-users to locate, identify and connect to hotspots while roaming.

Operators without Wi-Fi networks

The WBA also assists operators who are focused on mobile and/or broadband technologies and who may not own any hotspots, to leverage the enablers created by the WBA, and the global Wi-Fi footprint of its members, in order to offer Wi-Fi roaming and mobile data offload to their users. In doing so, the WBA helps mobile operators to address the challenges and opportunities created by an explosive growth in mobile data usage and the increasing availability of dual-mode 3G/Wi-Fi devices such as smartphones, laptops, tablets, game consoles, cameras etc. Similarly, it helps fixed broadband operators to offer seamless Wi-Fi roaming to their subscribers. The key enabler created by the WBA to facilitate intra-technology roaming and data offload is the Wireless Roaming Intermediary eXchange (WRIX) framework.

Wi-Fi roaming services enable network operators to provide authenticated access to their network without owning the user relationship. This section will provide an overview of the strategies that can be employed, as well as key considerations before entering into a Wi-Fi roaming relationship. The network owner can enter into a roaming agreement with a connection aggregator with potentially very little effort by making an agreement with a Wi-Fi aggregator who takes care of authentication and billing. Taking a bigger part of the infrastructure might make financial and strategic sense for some network operators but not for others. Operators should also take into account the fact that successful roaming agreements will increase the amount of traffic on their networks.

2.2 Roaming architecture

To provide Wi-Fi roaming services, the VNP and HSP must have interoperability mechanisms in place. Figure 3 illustrates the most common wireless LAN-to-Wireless LAN (WLAN-to-WLAN) roaming architecture based on the GSM Association's PRD IR.61.
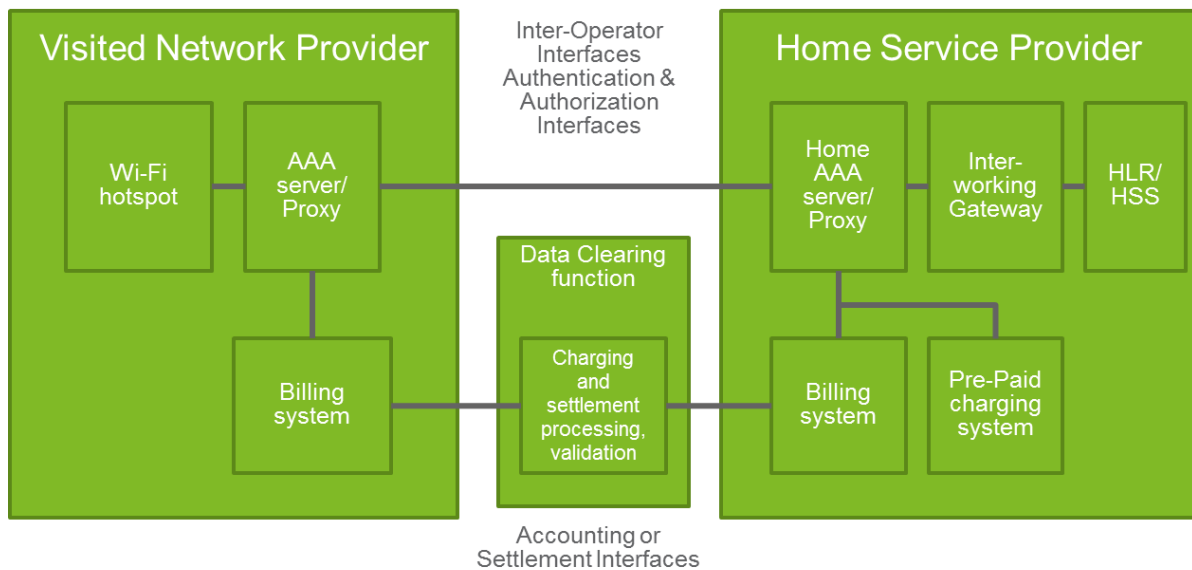
Figure 3: Typical WLAN roaming architecture

The visited network provides the connectivity to the client devices, but redirects the initial authentication of the roaming client devices to the home network AAA servers, typically via RADIUS (Remote Authentication Dial In User Service) proxy or from the Access Controller. Connection between the networks must be secured using private circuits, MPLS or Virtual Private Network (VPN) tunnels. The authentication can be done between the home and visitor networks while outsourcing the accounting for billing purposes to a third party. RADIUS accounting is not without loss, so accounting records between the home and visited network providers might differ from each other. If sufficient resources cannot be allocated to compare the records and manage the discrepancies, the accounting should be outsourced to a third party.

Figure 3 does not show a policy controller, which is mandatory in some countries and for operators of a certain size. It is used to set the access policies to roaming customers and can provide feedback from both the visited and home network operators as well as the venue where the users are located.

Operators may have different approaches when developing a roaming strategy. There are two main scenarios available to operators to interconnect their networks, either through a direct connection or by using a third party to facilitate that interconnection. For the latter there could be several hybrid models from both operators using the same hub or just one operator using a hub provider (see figures 4 and 5).
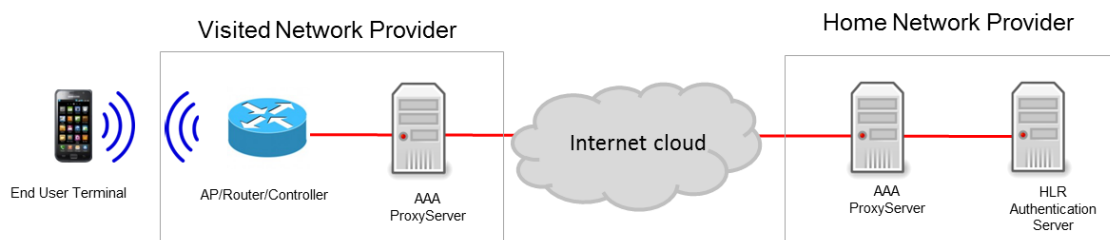

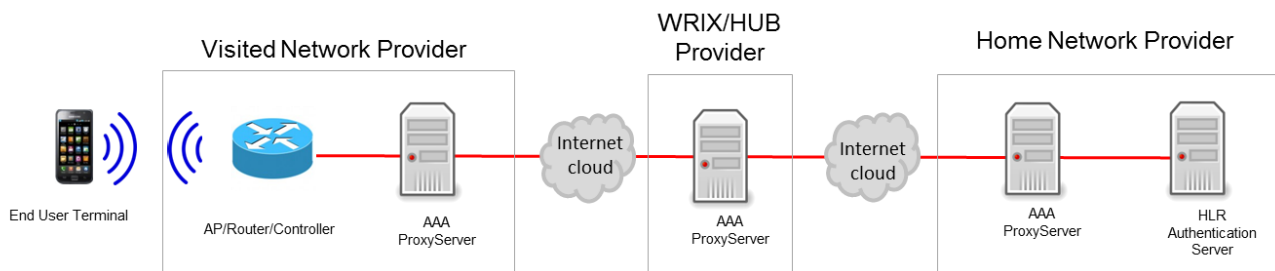Figure 4: WLAN roaming bilateral direct interconnection

Figure 5: WLAN roaming bilateral interconnection using a third party provider

2.3 Roaming partners/players

When choosing a roaming partner, several strategies can be pursued in parallel in order to obtain the necessary coverage to meet your business needs. Strategies are not all the same, and partners will have different needs and requirements. As well as the categories of operators we outlined when looking at the Wi-Fi ecosystem—pure Wi-Fi operators, mobile operators, fixed and cable operators, and integrated operators—there are also:

- Wi-Fi aggregators / resellers: These are companies that may have their own Wi-Fi network but that also provide access to other networks through common credentials.
- Wi-Fi roaming hubs / WRIX providers: These are organizations that connect Wi-Fi providers or companies wanting to roam on several other Wi-Fi networks through a hub. The Wi-Fi company only has to take care of the initial integration to the hub, which then connects them to a multitude of other providers.
- Wi-Fi Bi-laterals: Operators just work together in order to implement theirs roaming agreements and technical integration.

2.4 Creating a roaming plan

Several different strategies can be adopted when creating a Wi-Fi roaming plan, and the choice will depend on factors such as time to market and whether the operator is a service provider, a network provider or both.

When creating a roaming plan, consider both resources and timing. Unless there is a significant cellular offload to a Wi-Fi network, the chances are that there is some spare capacity in Wi-Fi networks.

For example, a network provider that has just upgraded from an 802.11g network to the latest dual radio 802.11n network can have ten times the wireless network capacity. The easiest way to get a lot of users onto the network is through a roaming partner. The uptake might surprise the network operator, so keep an eye on the usage and prepare for a very quick ramp-up. Network operators should also closely monitor any failed roaming attempts and users' data usage profiles. In addition, if you are a service provider operating a network that already has a lot of usage, you need to consider how heavier usage through a roaming partnership might affect your network.

2.5 Interoperability, charging, billing and financial services

There are several common models for billing and settlement of charges related to roaming services between the HSP and the VNP. The roaming terms agreed to by the HSP and VNP define the wholesale rates the VNP will charge the HSP for its subscribers' roaming activity on the VNP's network. Under these roaming agreements, the HSP independently charges its subscribers separately based on their own specific subscriber agreement.

Most wholesale charging models covered in roaming agreements are based on service-based tariffs. The rates are commonly based on one or more of the following rating models:

- Service Access Model (event based) – charging one flat wholesale rate for access at a specific location (includes 24-hour flat rate model).
- Data Volume Model – charging based on data used by the HSP's subscriber while roaming on the VNP's network.
- Connection-Time Model – charging based on the duration of time that the HSP's subscriber roams on the VNP's network.
- Location-Based Model – charging based on a specific venue type (i.e. premium locations such as airports or hotels).

Additional charging model features may include other pricing controls such as tiered pricing and subscriber usage caps which further define discounts or spending controls.

Once the charging models have been defined the WBA provides a framework for the interconnection, exchange of billing and settlement information. These processes provide a common framework for the exchange of all relevant information between roaming partners.

- WRIX-I - provides a guide for standard service specifications defined for interconnection between the VNP and HSP.
- WRIX-d – provides the mechanism for the exchange of session information needed to support wholesale billing and settlement (Data Clearing) between the VNP and HSP. This process covers the mechanism for the exchange of Usage Detail Records (UDRs) used in billing validation.
- WRIX-f – describes a mechanism for the exchange of invoices and payments between the VNP and HSP.

Other models such as those defined by the GSMA may also be used in order to allow roaming partners to follow processes currently used in their other roaming relationships.

2.6 User experience and customer care

Basic roaming capability is defined as being supported between two operators (Operator A and Operator B) when Operator A's customers are able to utilize Operator B's network(s) using their Operator A identity credentials, and vice-versa. Such operations should be as seamless, consistent and easy to use as possible.

Web-based authentication is still the most common method of authentication in Wi-Fi hotspots. Nevertheless, several industry initiatives are making automatic authentication over Wi-Fi networks available for customers. With web-based authentication it´s important to guarantee that a sufficiently consistent user experience is implemented when customers travel from country to country and network to network. This makes it vital that a standardized approach is developed by the WBA.

- Due to the nature of Wi-Fi roaming services it is important that operators are able to give proper customer support in the following areas: If a customer cannot access Wi-Fi as expected at a location, there needs to be a customer support mechanism in place to suggest an alternative
- Roaming users are usually unfamiliar with the local language so English support is important
- Websites have different designs and layouts that may complicate the use of the service
- When customers are in a different country they may not be aware of local cultures and specifics, such as venue opening times, which can affect the availability of the Wi-Fi service.

2.7   Hotspots list

It is important to be able to communicate relevant information about hotspots to potential users. Roaming users are almost always unfamiliar with the surroundings, so a simple address will not help much in terms of finding the hotspot. Most hotspot lists have the venue name, type, contact details and location, which enables the provider to guide smartphone users to the hotspot using a map application, for this propose WBA put in place the WRIX-L standard to harmonize the collection of Hotspot information. This assumes that we know which of the many location formats is being used (for example, WGS84). Venue types are also relevant. Hotels might be chosen by end-users according to the connectivity they have and retail locations preferred if they have a hotspot available. Some locations have restrictions: for example, an airport lounge might not allow everyone to enter; and access to a meeting room inside an office building is not straightforward. It's also useful to know the opening hours of a retail location. And it's important to keep the hotspot list up to date so that users can choose from all the potential hotspots and won't be misdirected to locations that do not offer a service.

2.8   WBA achievements

The Wireless Broadband Alliance (WBA) was founded in 2003 by a unique mix of Wi-Fi, mobile and broadband operators who viewed public Wi-Fi as a strategic complement to their cellular, cable and xDSL network(s) because from the outset interoperability between networks and roaming was a key area of activity.

The first roaming interoperability trial launched by the WBA took place in late 2003, and in 2004 the first commercial Wi-Fi roaming agreement was launched.

The WBA started with 5 members, all of whom were operators, and today it maintains a strong operator heritage but is open to all ecosystem partners interested in enabling a seamless Wi-Fi experience across technologies, devices and networks. It currently has more than 85 members from all regions of the world with different sizes and backgrounds (mobile operators, integrated operators, hub providers, technology players, etc).

One of the major achievements of the WBA has been the definition of the Wireless Roaming Intermediary eXchange (WRIX). This standard for Wi-Fi roaming was adopted by WBA members in 2006-7 and today is seen as the most relevant framework for Wi-Fi roaming services.

Today WBA members serve more than 390 million customers and have rolled out over 290,000 hotspots worldwide. Analysts predict that the number of available hotspots will increase dramatically over the next few years to reach around 6 million by 2015, as shown in Figure 6.

Global number of public Hotspots, 2009-2015
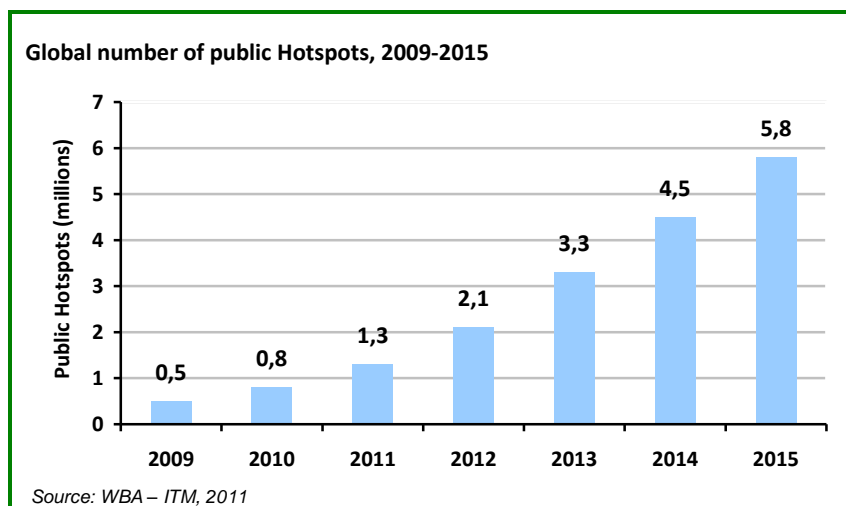
Source: WBA – ITM, 2011

Figure 6: Number of public hotspots globally, 2009-2015

Each year the WBA carries out a survey to gauge the wireless broadband developments and intentions of its members. According to the WBA's latest annual survey (October 2012), a slight majority of operators, 50,3%, negotiate roaming agreements via roaming hubs, while 49,7% are negotiated bilaterally.

The survey shows that there is significant potential for operators to increase the number of users that connect to international roaming Wi-Fi hotspots offered through agreements with foreign operators. The majority of operators, 75%, say that less than 10% of their overall user base connects to negotiated Wi-Fi hotspots while traveling (see figure 7).
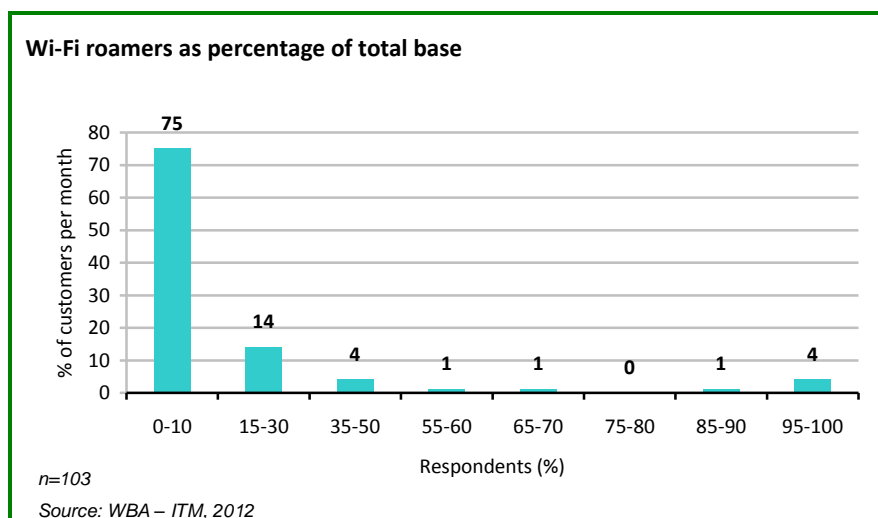

Figure 7: International Wi-Fi roaming customers as a percentage of total customer base

These findings point to the considerable scope operators have to:

- Increase the number of Wi-Fi roaming agreements.
- Make it easier for subscribers to connect to Wi-Fi hotspots offered as part of roaming negotiations.
- Implement technology that automatically connects users to Wi-Fi hotspots while roaming.
- Make users aware they can access Wi-Fi hotspots while traveling.
- Include Wi-Fi roaming as part of users' international data roaming service plans, or offer at incremental cost.
- Develop applications that allow users to monitor data roaming expenditure, as well as manage log-ins to Wi-Fi roaming access points that are offered as part of the home operator's negotiated Wi-Fi roaming offering.

The survey highlights the extent to which operators can increase the number of their international Wi-Fi roaming agreements, with the majority, around two-thirds having fewer than 20 agreements in place (see figure 8).

How many Wi-Fi roaming agreements do you have?

Nº of Agreements

Note: Only those that entered a number above 1 were counted. N=39
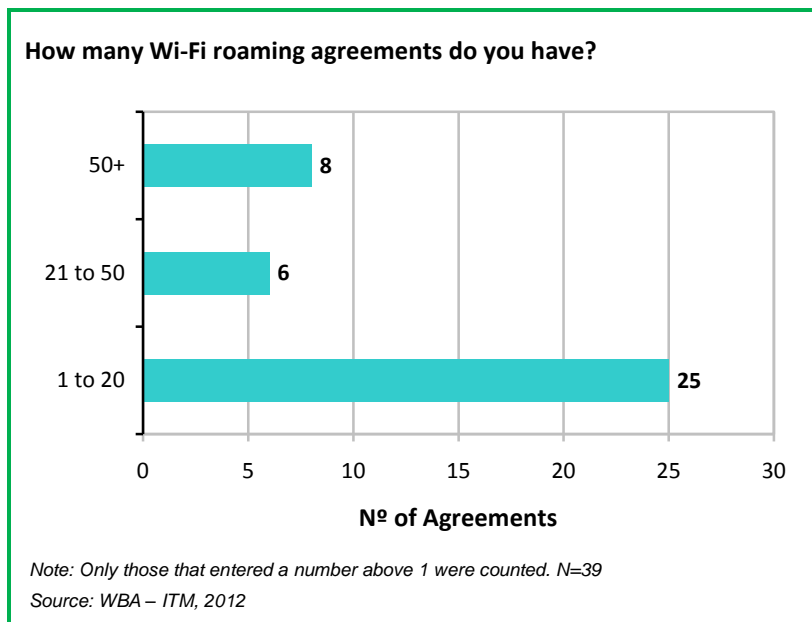
Source: WBA – ITM, 2012

Figure 8: Number of international Wi-Fi roaming agreements

The report also shows that there is significant disparity in the number of Wi-Fi hotspots available to subscribers via roaming agreements. The majority of operators, 30%, have 1,000 to 4,999 Wi-Fi hotspots available to customers via international Wi-Fi roaming agreements, while 9% have as many as one million to two million (see figure 9).
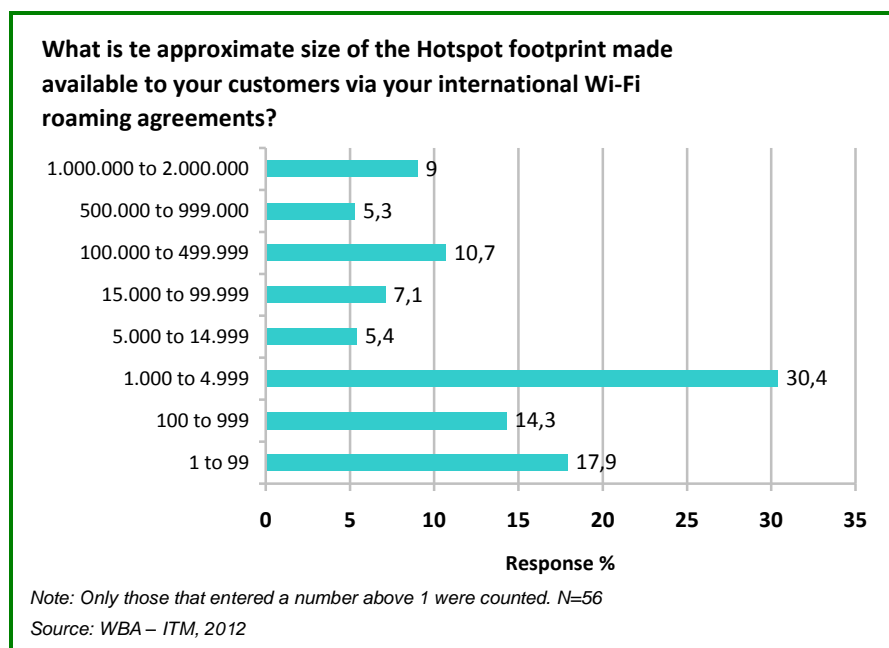

What is te approximate size of the Hotspot footprint made available to your customers via your international Wi-Fi roaming agreements?

Response %

Note: Only those that entered a number above 1 were counted. N=56

Source: WBA – ITM, 2012

Figure 9: Number of international Wi-Fi roaming hotspots available to customers

3. SETTING UP ROAMING SERVICES

3.1 Introduction

The WBA roaming process is summarized under the term WRIX or Wireless Roaming Intermediary eXchange. The WRIX roaming process consists of the following functional blocks:

- WRIX-i – Interconnection
- WRIX-d – Data Clearing
- WRIX-f – Financial Clearing
- WRIX-l - Location Feed Format and File Exchange Standard

The WRIX-i specification includes descriptions and definitions of the WRIX compliant Network, RADIUS interface, VPN connections, WLAN session mediation, UDR creation and service levels.

The WRIX clearing specification covers WRIX-d and WRIX-f including the XML-based data format: UDR (Usage Detail Record) for data clearing and SFD (Summary Financial Data) for financial clearing.

During the financial settlement the NPR (Net Payment Report) XML format can be used for data exchange.

The WRIX-l specification defines the format and data that operators should exchange for feeds of partner service locations, including both the file format and file exchange method.

In addition to the WRIX specification a set of documents is available for the implementation and maintenance of a Wi-Fi roaming agreement. These are:

- Technical Exchange Document (TED)
- Commercial and Business Exchange Document (CBED)
- User Experience (UE) Recommendations
- Fault Management, Troubleshooting and Customer Care Guidelines
- Location Feed template

The WRIX ID identifies the VNP and HSP. The identifier list of network providers is maintained by the WBA. The ID is a string of variable length containing the operator name and country code. The XML file names contain the VNP and HSP WRIX ID, the billing month and a sequence number.

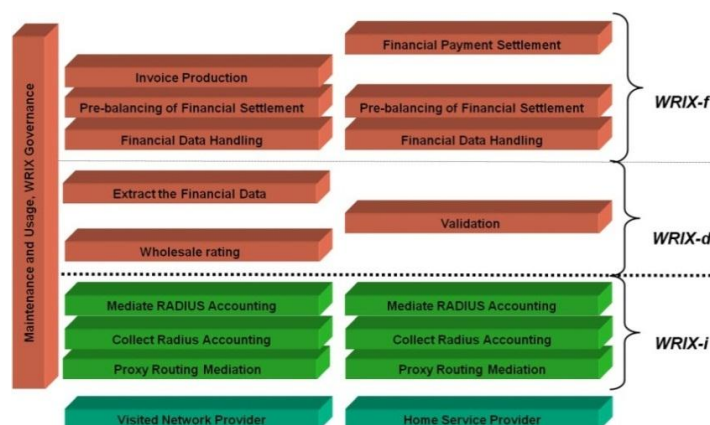Figure 10 describes the functional scope of each block on a wholesale level:

Figure 10: Functional scope of WRIX blocks.

3.2   Roaming contract

The WBA provides roaming agreement templates for both bilateral and aggregator models. The operators initiate commercial negotiations and have the flexibility to change the roaming agreement template to address their specific needs.

The template has 4 annexes:

- Service manual providing general guidance on requisites for the technical implementation of the agreement
- Pricing
- Contact details of the operational teams that will manage the agreement
- List of distributors that have an interest in that agreement (some operators may have several specific services).

The participating parties usually start with the commercial negotiation but in parallel initiate the technical implementation and the user experience tests.

3.3   Technical Exchange Document

The WBA has created a document which defines the process used for the exchange of technical information between operators when establishing Wi-Fi roaming. This document is known as the Wi-Fi Technical Exchange Document (TED). The goal of the TED is to communicate, in a consistent manner, key information needed for the implementation of a Wi-Fi roaming relationship, including:

- Company Information
- Roaming Configuration Information
- WLAN Home Service Brand Identification
- Wi-Fi Network Information
- RADIUS Server Configuration
- RADIUS Signaling Information
- IPSEC TUNNEL Information
- RADIUS VSAs and Attribute information
- Hotspot Directory Information
- HUB Information
- Contact Information

The use of the TED will simplify implementation and enable partners to quickly assess any technical gaps, thereby reducing the time it takes to implement the roaming agreement. The TED draws its source information from key industry reference documents such as the WRIX Interconnect document and WISPr (Wireless Internet Service Provider roaming), and it also has an accompanying Wi-Fi Technical Exchange Document Information Guide to help new users complete a TED for exchange with a new roaming partner.

The TED document and the TED Information Guide are available to members and non-members of the WBA. For more information on this document please visit the WBA website at www.wballiance.com.

3.4 Commercial Business Exchange Document

In addition to providing a template to assist with technical configuration requirements, the WBA has also defined a document which covers the exchange of information related to the settlement and billing associated with commercial Wi-Fi roaming agreements. This document is known as the Commercial Business Exchange Document (CBED). The CBED provides a mechanism to simplify the exchange of billing information which in turn will simplify the settlement process. The information exchanged via the CBED includes the following:

- Company Details
- Contact Information
- Clearinghouse Information (Data and FCL Clearinghouse identification)
- Roaming Configuration
- Billing Information for Accounts Payable
- Billing Information for Accounts Receivable
- Wiring Instructions for Payments
- Currency Management
- Usage File Exchange for Invoice Reconciliation
- User Access Options
- Rating Defaults
- SIM Card Handling Instructions.

Using the CBED will simplify billing and settlement configuration between partners, thus reducing the time it takes to implement a roaming agreement. It will also ensure that billing and invoice reconciliation are properly set up, and that critical information is delivered to the billing departments in a timely manner. The CBED draws its source information from key industry reference documents such as the WRIX Clearing document and other industry best practices. The CBED also has an accompanying information guide (Commercial Business Exchange Document Information Guide) which assists new users with completing a CBED for exchange with a new roaming partner.

The CBED document and the CBED Information Guide are available to members and non-members of the WBA. For more information on this document please visit the WBA website at www.wballiance.com.

3.5 Interconnection and testing (WRIX-i)

The WBA provides a guide for standard service specifications defined for interconnection between the VNP and HSP. The WBA roaming model facilitates wireless broadband service between VNPs and HSPs without requiring bilateral roaming (i.e. direct connectivity between operators).

In order for a roaming event to occur and settlement to take place, authentication, authorization and accounting (AAA) packets and data clearing/financial net settlement processing must have a transport medium available between the operators and WRIX-i providers. The WRIX-i document defines the following processes:

IP Connectivity - WRIX-i describes the requirements of the IP connections between the VNP and the HSP that support the authentication and accounting processes based on the RADIUS protocols. The most frequently used connections are IPSec Virtual Private Networks (VPNs), which are secure and can be used over existing connections to the internet. Since IPSec VPN is the preferred connectivity method, specific security procedures should be employed to safeguard data confidentiality and security. IPSec VPN is a standardized, well-known protocol that is implemented and supported in various classes of equipment, including routers, firewalls and dedicated hardware gateways from multiple vendors.

RADIUS Connectivity - WRIX-i uses the RADIUS Authentication, Authorization and Accounting (AAA) framework, defining the Radius Attributes that should be used for access and accounting processes.

RADIUS Mediation Rules - WRIX-i defines a set of standard mediation rules with which all WBA members must comply in determining valid RADIUS session definitions, including: Event Sequence, Session Definition, Session Mediation and Usage Detail Record (UDR) Generation.

Specifically, how two roaming partners (HSP and VNP) physically identify, count and bill each other for volume-based traffic is addressed in WRIX-d (section 3.1 and 3.3) and WRIX-i section 3.4 Session Mediation.

This defines how to populate the WRIX-d UsedVolumeDownLink and UsedVolumeUpLink fields for a session and conversion to kilobytes and enable HSP and VNP to identify volume-based usage and charge in accordance with their agreed Inter Operator Tariffs (IOT).

Service Levels to establish roaming - WRIX-i supports the implementation of Key Performance Indicators (e.g. RADIUS Server Uptime / Availability or IP Connectivity) to provide guidance in negotiating a Service Level Agreement (SLA) and maintaining end-to-end quality of the WLAN roaming service between WBA member operators.
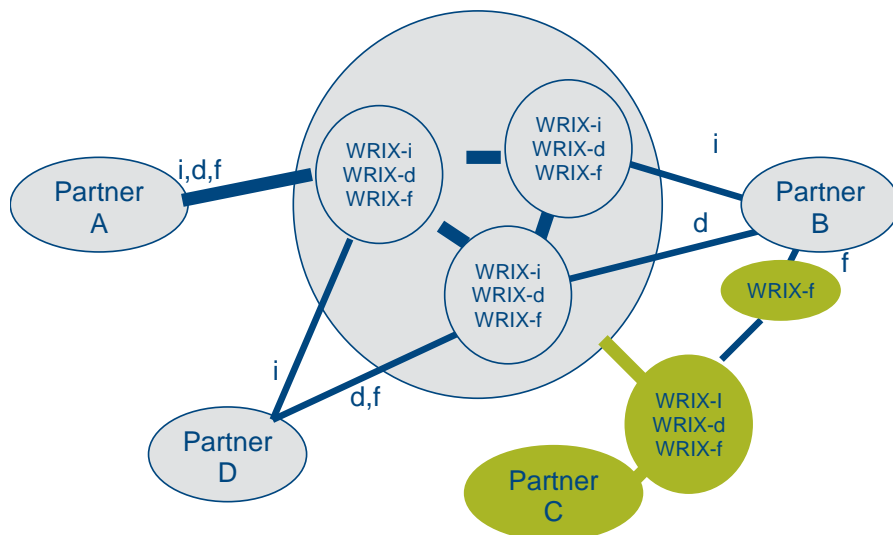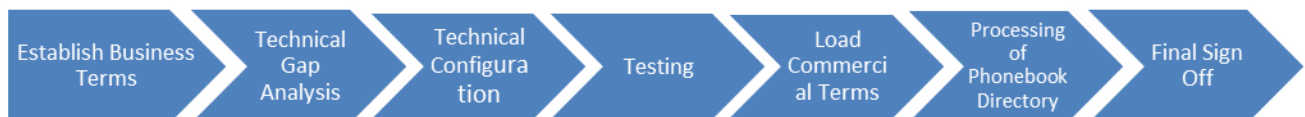

Figure 11: IP WRIX requirements

Typically, each company has a process it will follow prior to establishing a roaming relationship with another carrier and which usually includes (but is not limited to) the following:

- Establish business terms – This step is usually accomplished via the signing of a roaming agreement, which sets the wholesale rates, nature of agreement (inbound, outbound or both), the type of authentication that will be supported and the settlement terms.

- Technical GAP Analysis – The companies meet to discuss their individual capabilities and the functionality supported on their networks. The WBA Technical Exchange Documents are exchanged by the two roaming partners.

- Technical Configuration – The configuration of the individual networks begins. Each company uses the other company's TED to configure their systems.

- Testing – The partners begin testing the inbound and outbound roaming between their networks and subscribers.

  - Technical testing - Functionality testing is done to validate authentication and association based on client- or web-based implementations. This will involve an exchange of test clients, SIM cards, and/or test login/passwords. It may also require an exchange of a test plan to test certain aspects of functionality related to client- or web-based login pages. Functionality testing should also confirm that WRIX processes and mandatory attributes are passed in access and accounting packets accordingly or as stipulated in the contract terms agreed upon.

  - Testing of billing/rating information - Test cases performed during functionality technical testing should be used to validate billing/rating information. Wholesale rates are checked for accuracy, and data clearing, reporting and charging principles may also be validated. Once all billing validations have been completed by the HSP, a WBA WRIX Clearing Annex Test Completion Certificate should be filled out and sent to the VNP operator.

  - WBA WRIX Interconnect Appendix 1 – This test suite is available for operators to test functionality of WRIX interconnect and billing validation needs. Operators may also want to provide additional test cases unique to their specific client development.

- Load Commercial Terms – The partners should exchange information related to the billing and payment processes so that billing and settlement can begin after the contract has been implemented.

- Processing of Phonebook Directory – The partners should receive the current copy of the other partner's phonebook directory based on the information provided in their TED. Any auditing of the phonebook for errors related to address/location information and venue type should be addressed during the implementation phases.

- Final Sign Off – The partners agree the configuration is complete and all functionality testing, billing/clearing validations and completion certificates have been sent. They then agree to a date when roaming can begin. Partners should exchange a launch letter which specifies the agreed date from which commercial roaming activity should take place, and the time at which operators should expect to see roaming traffic on each other's networks.

The following links are to the location on the WBA website (www.wballiance.com) where the WRIX-i latest version is stored and the Appendix (Test Suite) - http://www.wballiance.com/resource-center/specifications/

3.6   User experience (UE)

Basic roaming capability is defined as being supported between two WBA member operators (Operator A and Operator B) when Operator A's customers are able to utilize Operator B's network(s) using their Operator A identity credentials, and vice-versa. Such operations should be available in as seamless and consistent a manner as possible, where the user experience plays a relevant role in facilitating the use of the Wi-Fi.

Basic roaming capability is defined as being supported between two WBA member operators (Operator A and Operator B) when Operator A's customers are able to utilize Operator B's network(s) using their Operator A identity credentials, and vice-versa. Such operations should be as seamless, consistent and easy to use as possible.

Basic roaming

Despite the recent development of using Wi-Fi networks via specific connection managers or advanced authentication methods such as EAP (Extensible Authentication Protocol), web-based authentication is still most commonly used in the Wi-Fi arena.

The WBA recommends that its members should adopt the Universal Access Method (UAM – web-based authentication) to enable their customers to gain easy and consistent access to services when roaming on fellow WBA member networks using a Wi-Fi enabled device. To this end the WBA has developed UE Guidelines in order to establish a sufficiently consistent user experience as customers travel from country to country and network to network. It is not designed as a user interface requirements document, nor is it intended to affect operator branding and design guidelines. The UAM user experience recommendations should be implemented within each operator's existing user interface concept.

The WBA UE Guidelines provide all the information that an operator requires to implement UAM over laptops and smartphones. It defines the main steps involved in performing a UAM, taking into account the web structure that is widely implemented in today's websites. The visited network operator should provide a service provider drop-down selection box on its main page to allow the guest user to select their HSP.

This drop-down selection box should be clearly visible above the fold on the landing page without the need for the guest user to have to scroll down the page.
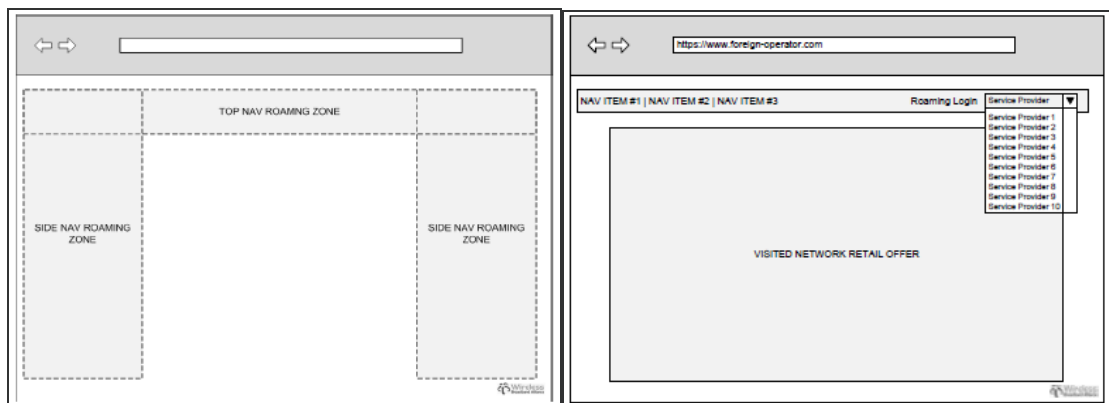

Figure 12: Recommended zones for roaming login presentation and example of drop-down selection box application (laptop)
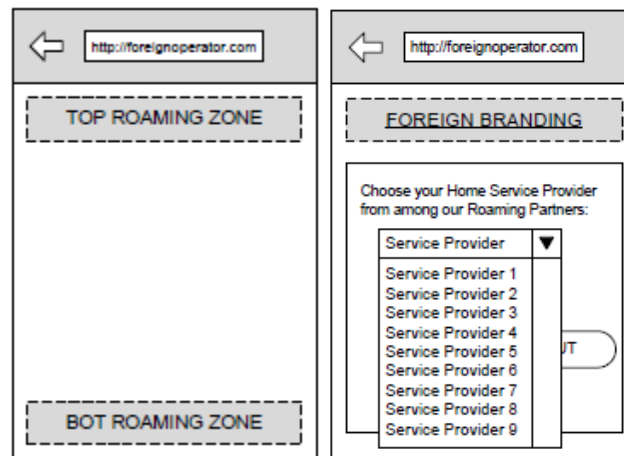
Figure 13: Recommended zones for roaming login presentation and example of drop-down selection box application (smartphone)

Additionally, the WBA provides guidance for the remote management of login pages. This defines the procedures that operators should follow in order to implement a remote mechanism to manage all the login pages that are available on the portals of all roaming partners worldwide. This procedure optimizes the necessary changes and updates to the login pages without having to contact each roaming partner.

3.7   Fault management and customer care

The WBA provides Fault Management, Troubleshooting and Customer Care Guidelines, which define the operational support and fault management processes that need to be implemented by each operator to support the global roaming service.

This document is intended to clearly outline the inter-operator interactions, escalation processes and event flows triggered by a fault report, a customer complaint or regular maintenance procedures.

The customer support scope and customer service requirements are defined, as well as the call handling processes.
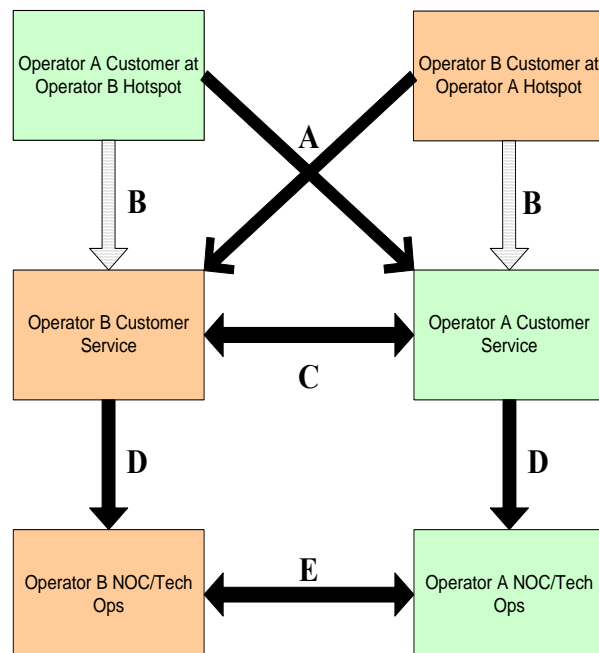
Figure 14: Process flow for customer complaints

A= Operator A customer at operator B hotspot calling operator A customer service and vice versa
B= Operator A customer at operator B hotspot calling operator B customer service and vice versa
C= Operator A customer service agent calling operator B customer service agent and vice versa
D= Operator A customer service agent escalating to operator A NOC agent and vice versa
E= Operator A NOC agent calling operator B NOC agent and vice versa

The guide defines the procedures, in terms of communication, that an operator must follow whenever the network configuration is changed so that it has an impact on the roaming service, or there is any change in customer care services that impact roaming service customers. It also defines the procedures for severity outages of the roaming service, including the hierarchy of severity issues, the responsibilities for home and visited service provider and the notification timelines for each type of outage.

3.8   Data and financial clearing (WRIX-d and –f)

The WBA provides a guide for standard service specifications defined for the data clearing and financial clearing processes between a VNP and HSP. The purpose of clearing is to enable inter-operator wholesale settlement in accordance with the billing requirements agreed upon between a VNP and HSP. The WRIX Clearing Standard Service Specification (SSS) provides mechanisms to facilitate data and financial clearing by defining files and flows for this purpose. These mechanisms allow for both bilateral clearing flows (one HSP roaming onto one VNP) and multilateral clearing flows (multiple HSPs roaming onto one VNP).

For data clearing, files must be exchanged at least once per month, and records cannot be older than 30 days. A daily transfer of records and a maximum record age of 48 hours are recommended. For financial clearing, the VNP and HSP often do a monthly reconciliation on traffic figures. Note that RADIUS records in Wi-Fi roaming are created at both the VNP and HSP at the same time. The information contained within these records is collected and used for the clearing processes.

The WRIX Clearing SSS document defines the files to be exchanged and describes the flows for transferring these files between a VNP and HSP (see figure 15).
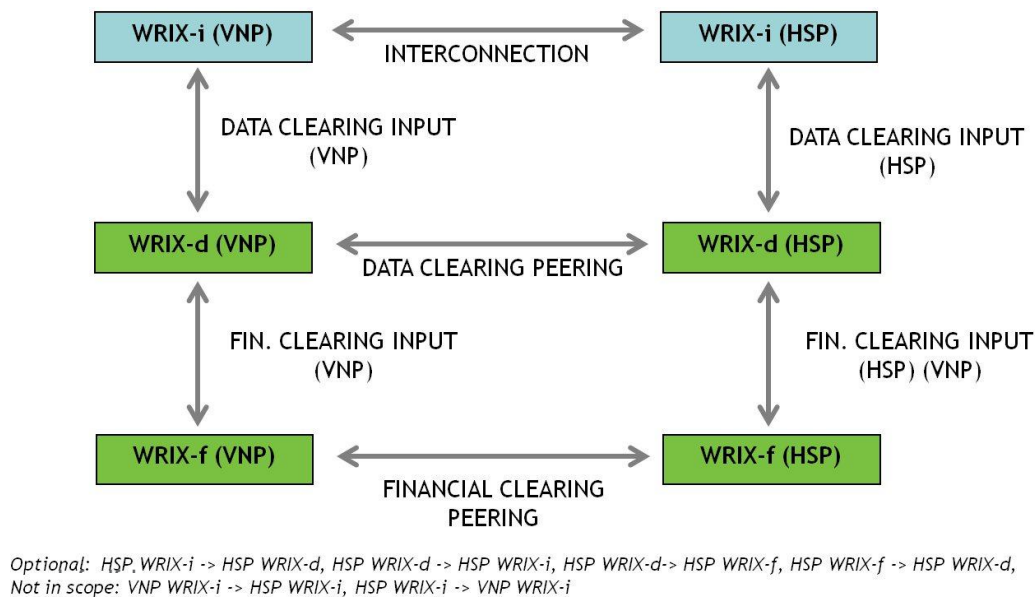
Figure 15: Interfaces for roaming and clearing processes

WRIX-d defines one file to be exchanged for data clearing, a Usage Detail Record (UDR). The UDR has two flows specified. The first flow, *UDR Input*, is an unrated UDR, which specifies usage recorded by the WRIX-i and presented to the WRIX-d for further processing. This exchange is required on the VNP side, but optional on the HSP side. The second flow, *UDR Peering*, defines an exchange for a rated UDR passed from the WRIX-d of the VNP to the WRIX-d of the HSP. The purpose of this second flow is to verify that billing happens according to the terms agreed upon between VNP and HSP.

WRIX-f defines two files to be exchanged for financial clearing. The first file is Summary Financial Data (SFD). The SFD includes one record per roaming partner, representing a summary of all traffic for one invoicing period. There are two flows specified for the SFD. The first flow, *SFD Input*, facilitates the exchange of data from the WRIX-d to the WRIX-f. This exchange is required on the VNP side, but optional on the HSP side. The second flow, *SFD Peering*, is the exchange of the SFD file from the VNP WRIX-f to the HSP WRIX-f. This exchange should create the basis for settlement and reconciliation.

The second WRIX-f file defined is the Net Payment Report (NPR). The NPR shows the payables and receivables per roaming relation. The flow of this file is specified between the WRIX-f entities of both parties. This exchange should create the basis for the final payment to be settled for the invoicing period.

The clearing flows provide a basic timeline and exchange process, and also define two generic feedback flows at a file level: a Missing Notification flow (MIN) and a File Acceptance Notification flow (FAN).

The MIN flow allows the receiver to indicate that there is a missing flow according to the specified timeline. A MIN can be sent at any time from the deadline for a missing flow, and must use the same implementation as the flow that is missing, including legal invoice. The missing notification must also be sent by post.

The FAN flow allows the receiver to indicate the result (accepted/rejected) of the review of the file that has been received. Files are either accepted or rejected at the file level, meaning an entire file must be rejected even if the file only has problems with a single record. A positive notification (OK FAN) for accepted files is not mandatory, unless otherwise specified between partners. A rejected notification (NOK FAN) can be sent up to 5 days after receipt of a flow/file. After this time a positive notification is assumed by the sender. The FAN must use the same implementation as the flow that is being accepted or rejected, including legal invoice. The rejection notification must also be sent by post.

The WRIX-d/f specification also defines test scenarios and certificates based on the Interconnection and Clearing flows. The following links are to the location on the WBA website (www.wballiance.com) where the latest version of the WRIX-d/f Clearing document is stored - http://www.wballiance.com/resource-center/specifications/

3.9   Hotspot identification (WRIX-L)

In order to provide a user-friendly and supportable service, HSPs require accurate information about the hotspots in their Wi-Fi roaming solution. The WRIX Location Feed Format & File Exchange Specification (WRIX-L) establishes the framework for the consistent definition and description of hotspots and the process by which the information is exchanged between HSPs and their Wi-Fi roaming partners.

The WRIX-L specification includes a combination of mandatory and optional fields which, at a minimum, identify the Service Set Identifier (SSID), supplier, geographic location, venue type and technical access requirements (e.g. security parameters) of an individual hotspot.

With this information, HSPs are able to provide guidance to their subscribers on how to locate hotspots included in their service offering; provide details to their customer support organization necessary to support subscribers; and provide their marketing and business intelligence teams with data useful to characterize their Wi-Fi roaming solution and the usage patterns of their subscribers. The specification accommodates variances in description language to ensure the practical value of the information, while at the same time allowing for normalization of attributes such as City Name and State/Province/Prefecture which might vary significantly between their native form and the English language translation which is the standard for the specification. This flexibility is important to facilitate international Wi-Fi roaming solutions.

Beyond language translation, it is important to have consistency in data attributes which describe the venue type in order to create an orderly directory and characterization of hotspots. The WRIX-L specification prescribes a standard set of location types covering hospitality, transportation, assembly and public venues. Definition of sub-location types which provide greater assistance in hotspot locator services are optional, but recommended.

Consistency in location ID is also critical. Standardization in this area allows data from the location feed to be used in conjunction with transaction records containing the same information, to enable detailed call detail records to be used for subscriber billing, operational reporting and service management. As with all attributes, consistency in this area is particularly important when location feeds from multiple roaming partners are aggregated to describe a Wi-Fi roaming service.

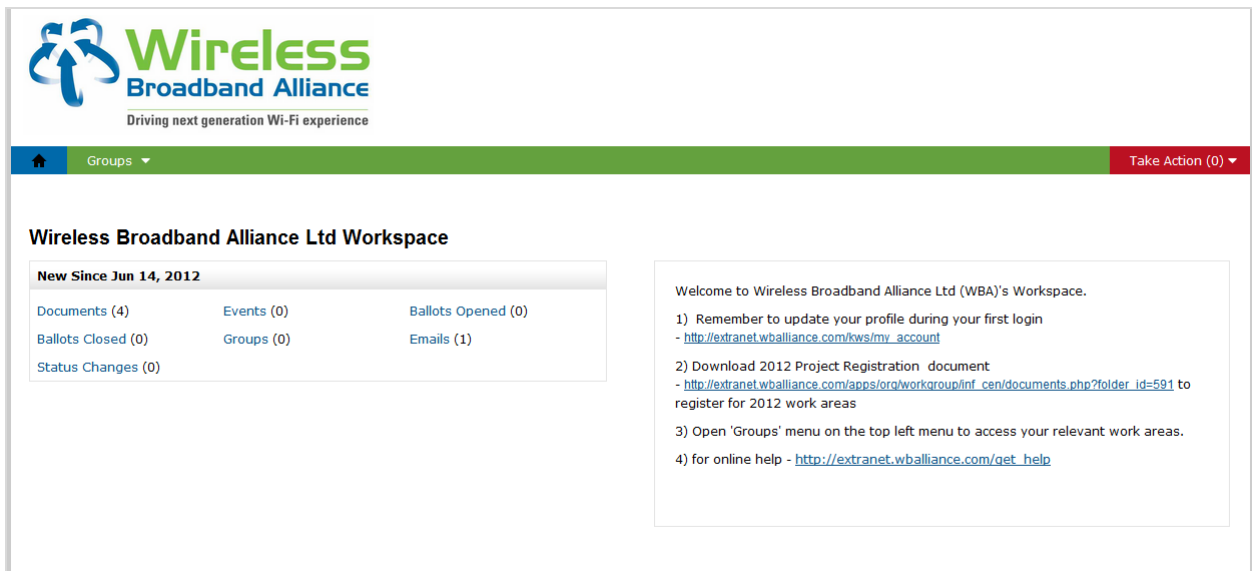The latest revision of the WRIX Location Feed Format & File Exchange Specification (WRIX-L) is available from the Wireless Broadband Alliance website at http://www.wballiance.com/resource-center/specifications/

4. DELIVERING & MAINTAINING ROAMING

4.1 WBA Workspace Extranet

Members of the WBA have exclusive access to the WBA Workspace Extranet (http://extranet.wballiance.com), which is a useful knowledge source on all topics covered by the WBA.

Through the Workspace, the community is able to keep up-to-date on the most important WBA topics such as working groups, meetings, knowledge bases, documents, contact details of roaming partners and much more.

In order to access the Workspace, you need a login username and password which will be provided on joining the WBA.

Below is the layout of the home page of the Workspace Extranet:

4.2 Finding and downloading documents (Information Center)

Within the Workspace there is a database, called Information Center, where all the official documents edited and approved by the WBA, both current and archived, are stored.

At the top left of the home page, there is an Information Center tab that leads to the following page:
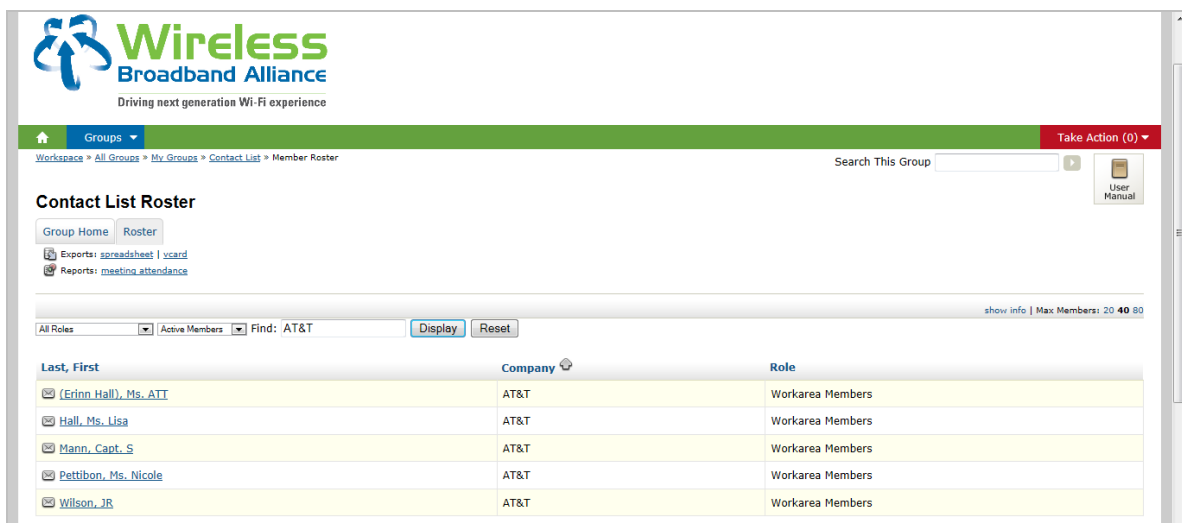
4.3   Contacting roaming partners

The best way to contact roaming partners will depend on the roaming strategy of the company and whether it involves making connections directly or through a WRIX hub provider. If the WRIX hub provider is a wholesale aggregator which provides access to roaming partners and adds a margin to the roaming traffic, it will contact potential roaming partners.

If the WRIX Hub provider operates a managed service (whereby access is provided to the footprint of roaming partners for a monthly or annual fee and with no margin added to the roaming traffic), roaming partners can be added without the need for direct contact by using a proxy agreement with roaming rates provided directly by the roaming partner. Should there be a requirement to negotiate a different commercial rate with a particular roaming partner, the managed service provider can facilitate a direct discussion between the two parties.

It is possible to identify roaming partners and information about them through the WBA Workspace Extranet so that direct contact can be made if required.

4.4   In-life contract management

The two parties, whether they are using a bi-lateral agreement or an agreement between a service provider and a WRIX hub provider, will agree the frequency, process and method of review. Typically, reviews are held on a quarterly basis, but may be on a monthly basis in the early stages of a roaming relationship.

When new roaming partners are added, the appropriate paperwork needs to be produced and the new roaming partner networks can be appended to the main roaming agreement.

The following table identifies the tasks necessary to maintain the roaming agreement and the regular procedures that should be carried out by the operators.

Area	Description	Relevant WBA Documents & Tasks
Hotspot Directory	Operators should exchange the hotspot directory on a regular basis so they are able to market and inform their customers of the locations where they can roam.	WRIX-L and its Appendix A – Location Feed Data Template Including the validation of new fields and file format
Fault Management and Customer care	Operators should confirm regularly that all operational support and fault management processes required are implemented.	Fault Management, Troubleshooting and Customer Care Guidelines
User Experience	Operators should regularly confirm that they are following the WBA procedures for User Experience, paying special attention to the login pages from the roaming partners, implemented on their roaming drop-down menu.	User Experience Guidelines
Phonebook Directory	Operators should regularly confirm that the contacts from their roaming partners are still valid, so that the TED and CBED documents can be exchanged and updated on a regular basis.	Technical Exchange Documents (TED) Commercial Business Exchange Document (CBED)
Technical Requirements	The operators should regularly check for updates on the WRIX framework from the WBA Roaming Working Group, paying special attention to official WBA communication.	WRIX framework

Figure 16: Regular activities to maintain a roaming agreement

5. WBA

Founded in 2003, the aim of the Wireless Broadband Alliance (WBA) is to secure an outstanding user experience through the global deployment of next-generation Wi-Fi. The WBA and its industry leading members are dedicated to delivering this quality experience through technology innovation, interoperability and robust security.

The organization's mission is to:

Facilitate adoption of Wi-Fi enabled services through improvements in user experience, interoperability and service delivery across technologies, devices and networks.

The objectives of the WBA are to:

- Provide an open forum to operators and technology partners for developing enablers, facilitating technical trials and roaming, and creating opportunities to engage the ecosystem and share learning.
- Cooperate with Industry forums and bodies to harmonize technical specifications necessary for a seamless Wi-Fi experience across technologies, devices and networks.
- Provide media, analysts and regulators with independent expert views and commentary on existing and emergent issues concerning Wi-Fi enabled services and the growth of the industry.
- Enable end-users to have a smooth, consistent and quality Wi-Fi experience.

The WBA concentrates its activities in 5 major areas:

- Sharing learning: Hosting dialogue forums, workshops, market update sessions, networking events; publishing whitepapers, case studies, success stories, newsletters; periodically conducting online briefings/market updates.

- Engaging the ecosystem: Establishing liaisons with other industry forums and facilitating joint working groups and board-to-board meetings; evangelizing public Wi-Fi through media/PR activities, industry conferences, road shows and new member recruitment.

- Developing enablers: Developing frameworks, guidelines, best practices, specifications (e.g. WRIX – i, d, f, l ; WISPr 2.0; User Experience Guidelines for smartphones).

- Conducting technical/pre-commercial trials (e.g. EAP over WISPr 2.0 trial and Next Generation Hotspot trial)

- Facilitating roaming: WBA Global Roaming Project, one-on-one meetings (e.g. for bilateral roaming etc), member roaming pack and roaming compliancy.

The WBA is organized into 3 working groups:

Business Working Group (BWG): Leads the development of business models/guidelines and supports programs to facilitate the delivery of an enhanced experience for the benefit of end-users.

Industry Engagement Working Group (IWG): Leads and manages industry engagements and supports outreach activities on behalf of WBA members to promote WBA's objectives and the enablers created by WBA members.

Roaming Working Group (RWG): Leads all WBA roaming programs and supports the development and maintenance of the technical enablers (specifications, guidelines, best practices, templates etc).

An important joint taskforce was set up in April 2011 by the GSM Association (GSMA) and the WBA to address Wi-Fi roaming, with the intention of bringing together the Wi-Fi and cellular ecosystems to achieve the following objectives:

- Make Wi-Fi-to-Wi-Fi roaming as easy and transparent as 3GPP roaming, leveraging GSMA experience

- Define and deliver a common technical implementation for 3GPP-to-Wi-Fi interworking for both devices and networks

- Ensure 3GPP-to-Wi-Fi integration is as seamless and transparent as possible to the customer

- Promote relevant activities across GSMA and WBA participants and foster greater awareness in the different geographic regions around the world

- Identify gaps in available standards and make recommendations to address these gaps

- Identify guidelines and recommendations to GSMA and WBA member companies to accelerate Wi-Fi roaming solutions based on jointly agreed requirements and standards

Ten topics were identified as high priority that should be addressed within the scope of the first phase taskforce and were clustered as follows:
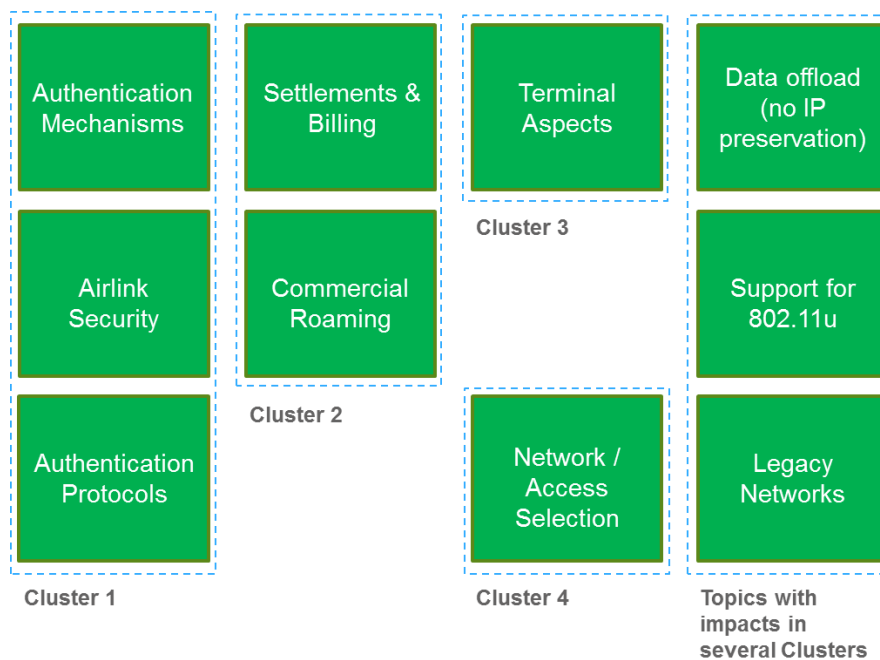

Figure 17: Joint GSMA – WBA taskforce clusters

For additional information about WBA and its activities please contact pmo@wballiance.com.

6. ANNEX A: ROAMING PROCESS DIAGRAM

Figure 18 below shows a summary of the processes involved in implementing a new roaming agreement, using a step-by-step approach and identifying the relevant WBA documents that should be used for each phase.

Step	Description	Relevant WBA Documents & Tasks
STEP 1: Establish Business Terms	• Typically this step is accomplished via the signing of a roaming agreement. • The companies sign an agreement which sets the wholesale rates, nature of agreement (inbound, outbound or both), the type of authentication that will be supported and the settlement terms.	• Roaming agreement templates • Commercial Business Exchange Document
STEP 2: Technical Gap Analysis	• Under this phase the companies meet to discuss their individual capabilities and the functionality supported on their networks. Both companies must identify the technical requirements to implement on the commercial roaming agreement.	• Technical Exchange Documents (TED) • The TEDs are exchanged by the two roaming partners.
STEP 3: Technical Configuration	• The configuration of the individual networks begins. Each company uses the other company's TED to configure their systems.	• Technical Exchange Documents (TED) • WRIX-i/d/f • User Experience Guidelines
STEP 4: Testing	• The partners begin testing the inbound and outbound roaming between their networks and subscribers. • Technical testing - functionality testing is done to validate Authentication and Association based on client- or web-based implementations. This will involve an exchange of test clients, SIM cards, and/or test login/passwords. • Testing of billing/rating information - test cases performed during functionality technical testing should be used to validate billing/rating information. Wholesale rates are checked for accuracy; data clearing, reporting and charging principles may also be validated.	• WRIX-i Appendix 1 – Test Suite • WRIX Clearing Annex Test • Once all billing validations have been completed by the HSP, a WBA WRIX Clearing Annex Test Completion Certificate should be filled out and sent to the VNP. • Operators may also want to provide additional test cases unique to their specific roaming agreement development.
STEP 5: Load Commercial Terms	• The partners should exchange information relating to the billing and payment processes so that billing and settlement can begin after the contract has been implemented.	• Commercial Business Exchange Document (CBED)
STEP 6: Processing of Phonebook Directory	• The partners should receive the current copy of the other partner's phonebook directory based on the information provided on their TED. Any auditing of the phonebook for errors relating to address/location information and venue type should be addressed during the implementation phases.	• Technical Exchange Documents (TED)
STEP 7: Final Sign Off	• The partners agree the configuration is complete, all functionality testing, billing/clearing validations and completion certificates have been sent, and they agree to a date when roaming can begin.	• Partners should exchange a launch letter which specifies the agreed date from which commercial roaming activity should take place, and the time at which operators should expect to see roaming traffic on each other's networks.

Figure 18: Step-by-step roaming implementation process

Acronyms And Abbreviations

Term	Description
3GPP	3rd Generation Partnership Project (www.3gpp.org)
802.11	802.11 is a set of standards carrying out wireless local area network (WLAN) computer communication in the 2.4, 3.6 and 5 GHz frequency bands. They are implemented by the IEEE LAN/MAN Standards Committee
802.11u	IEEE 802.11 standard for WLAN interworking with external networks
AAA	Authentication, Authorization and Accounting. A method for transmitting roaming access requests in the form of user credentials (typically user@domain and password) service authorization, and session accounting details between devices and networks in a real-time manner.
AP	Access Point
EAP	Extensible Authentication Protocol or EAP is used to pass the authentication information between the supplicant (e.g. the Wi-Fi device) and the authentication server (usually a radius server). The actual authentication is defined and handled by the EAP type.
EAP-SIM	Extensible Authentication Protocol Method for GSM Subscriber Identity, or EAP-SIM, is an Extensible Authentication Protocol (EAP) mechanism for authentication and session key distribution using the Global System for Mobile Communications (GSM) Subscriber Identity Module (SIM).
HLR	Home Location Register
IPsec tunnel	IPsec (IP security) is a standard for securing Internet Protocol (IP) communications by encrypting and/or authenticating all IP packets. IPsec provides security at the network layer.
NGH	Next Generation Hotspot
Passpoint™	Enables mobile devices to automatically discover and connect to Wi-Fi networks. Passpoint also automatically configures industry-standard WPA2™ security protections without user intervention. Passpoint certifies products which implement technology defined in the Wi-Fi Alliance Hotspot 2.0 Technical Specification.
PRD IR.61	WLAN Roaming Guidelines (Inter-Operator Handbook).
Radius	Remote Access Dial-Up User Service. A standard technology used by many major corporations to protect access to wireless networks.
SSID	A unique 32-character network name, or identifier, that differentiates one wireless LAN from another. All access points and clients attempting to connect to a specific WLAN must use the same SSID.
WGS84	World Geodetic System of 1984, commonly used by organizations that provide GIS data for the entire globe or many countries and used by most web-based mapping engines.
WISPr	"Wireless Internet Service Provider roaming". This is a best practices document available in the public domain. This protocol defines the Smart Client to Access Gateway interface. This Universal Access Method (UAM)protocol has become widely used to access public IEEE 802.11
WRIX	Wireless Roaming Intermediary eXchange – a modular set of standard service specifications to facilitate commercial roaming between operators. It includes WRIX-i (Interconnect), WRIX-d (Data Clearing), WRIX-f (Financial Settlement) and WRIX-L (Location). Each of these can be deployed by Visited Network Providers (VNPs) and Home Service Providers (HSPs) either in-house or through an intermediary WRIX service provider.

Document History

Version	Revision date	Revised by	Description of change
1.0	11 May 2012	Tiago Rodrigues	First draft of the Roaming WP
1.1	26 November 2012	Tiago Rodrigues	Final document after editor revision
1.2	12 December 2012	Tiago Rodrigues	Final inputs from project team

Participant List

Name	Company
Erinn Hall	AT&T
Lisa Hall	AT&T
Stephen Rayment	Ericsson
Betty Cockrell	BSG Clearing Solutions
Michael Sym	BSG Clearing Solutions
Sami Susiaho	BSKYB/ TheCloud
Andrew Haworth	BT
Quentin Birchall	Connection Services
David Valerdi	Fon Wireless Ltd.
Steve Namaseevayum	iPass Inc.
Blaz Vavpetic	iPass, Inc.
James Murphy	Juniper Networks
Carolyn Heide	Ruckus Wireless
Christian Laroche	Shaw Communications
Tim Dobbing	Shaw Communications
Arnel Cervantes	SMART Communications
Ellen Encinares	SMART Communications
Marie Therese Romano	SMART Communications
Ahmed Bencheikh	Time Warner Cable
Tiago Rodrigues	WBA